ONTARIO
MINISTRY OF THE ENVIRONMENT

MOBILE AIR MONITORING (MAM) UNIT

Ontario
Ministry of the Environment
Hon. Harry C. Parrott, D.D.S., Minister
Graham W. S. Scott, Q.C., Deputy Minister

Air Resources Branch
Monitoring & Instrumentation
Development Unit
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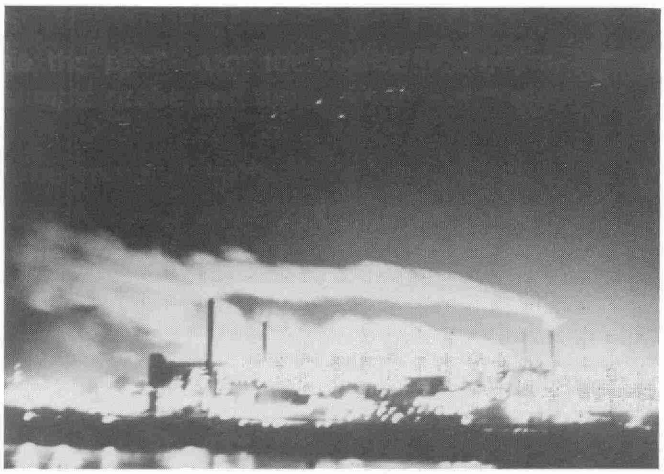
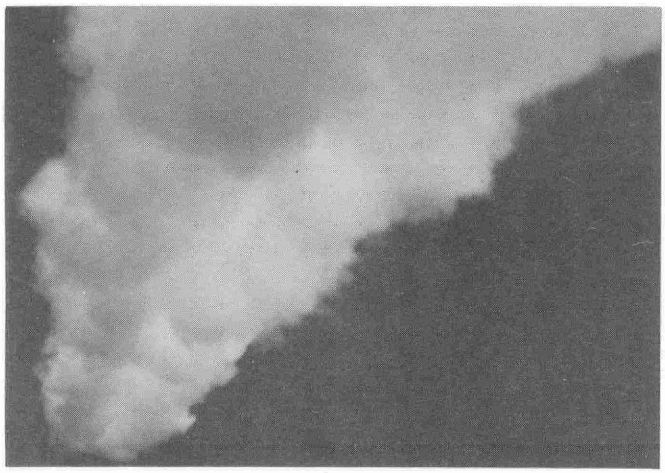
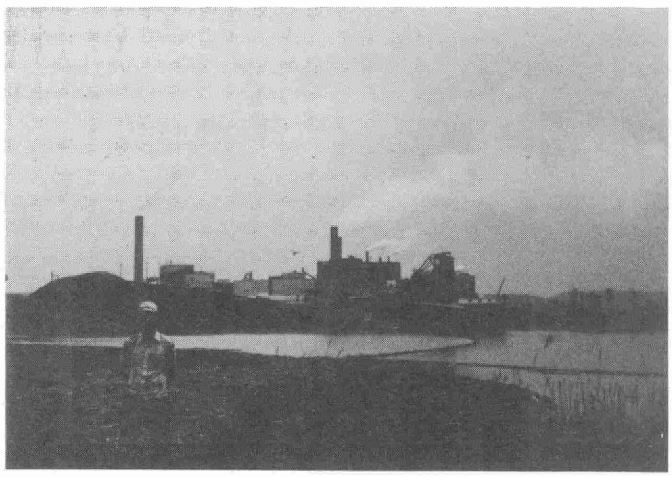


PULP & PAPER MILL

KRAFT MILL



PLUME FROM A POWER GENERATING STATION



PULP & PAPER MILL

Air pollution is a matter of vital concern to us all. Air is our main link with life, far exceeding our dependence on food and water. Air quality must be protected for this reason.

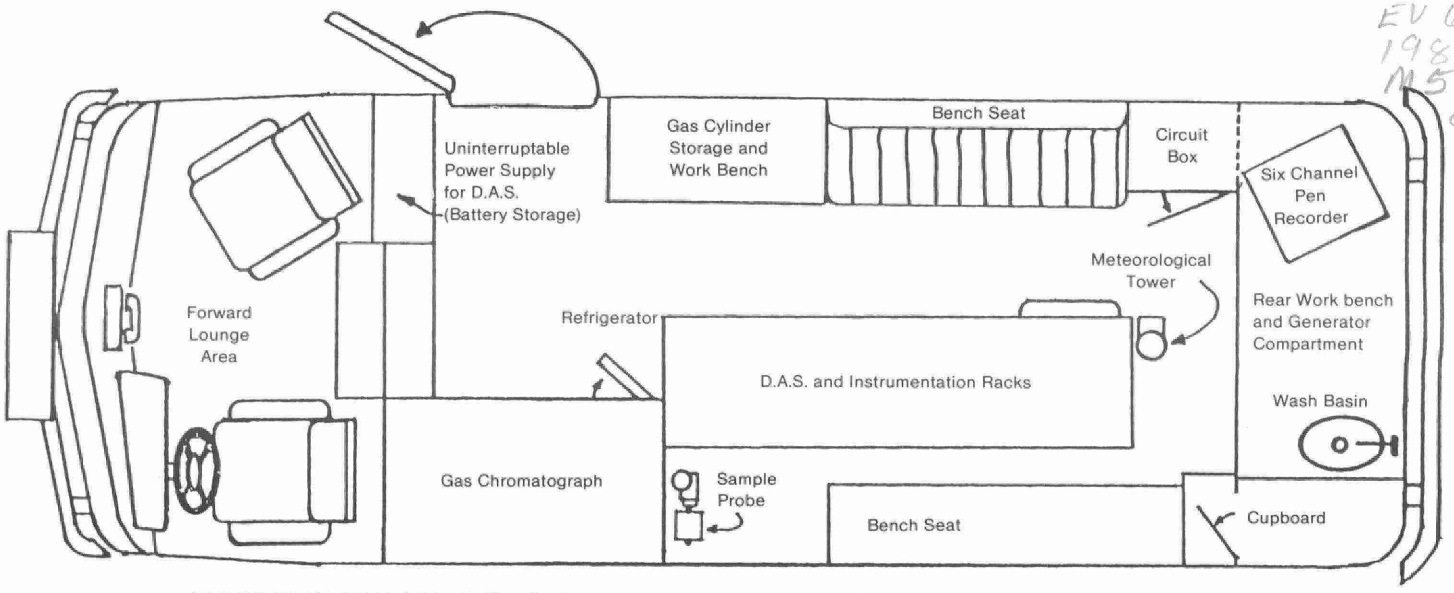
Anything in the atmosphere that causes discomfort or endangers health, injures plants or animals, ruins the enjoyment of property . . . according to Ontario Law is air pollution.

Air pollution monitoring is a highly sophisticated science that requires state of the art technological equipment and the attention of professionals from many specialized disciplines.

The major goal of air management in Ontario is the steady improvement of ambient air quality across the province. The result of the air management programs has been the reduction of emissions from sources or the reduction of ground level concentration of pollutants by abatement devices and equipment at the source.

The success of these management/abatement programs has been monitored with the help of permanently fixed monitoring sites and fully equipped mobile laboratories such as Mobile Air Monitoring Unit II (MAM Unit II).

The collection and subsequent analysis of air samples is the foundation of Ministry's air pollution control program. The legislative authority for the program is provided by regulations under the Environmental Protection Act, 1971. As more facts about air pollution become known, these regulations and the act itself will become improved and modified.



FLOOR PLAN OF M.A.M. UNIT II SHOWS LAYOUT OF INSTRUMENTATION, DATA ACQUISITION SYSTEM (D.A.S.), STORAGE AND LOUNGING AREA

The MAM Unit was conceptualized in 1976 from the need to accurately and quickly determine air quality profiles from ambient air. The 'mobile' concept was specifically requested to deal with air pollution emergencies and/or other special studies.

The Technology Development and Appraisal (TDA) Section of the ARB, was given responsibility for the research, design, and construction of the MAM Unit. Preliminary research was necessary to set minimum standards and objectives to be met during the construction phase. Quality, reliability, flexibility, safety and comfort were prime objectives considered during this design stage.

A standard 23 foot GMC Transmode Mobile Home was chosen to be converted into the mobile laboratory. It was chosen because of many unique practical features. The gross vehicle weight rating is 13,000 lbs.; adequate for instrumentation and personnel loads. It also has the feature of an adjustable air suspension that can level the van on irregular surfaces. This front wheel drive vehicle provides sufficient flat floor space and has proven to be predictable and safe for any type of driving under full load conditions.

The unit has two – six thousand watt Onan air cooled generators which are mounted in the rear of the vehicle. These generators are electronically governed to minimize frequency/voltage fluctuations. Two 400 cfm blowers provide additional air convection for cooling in extremely hot, humid and dusty conditions. To minimize transmission of vibrations, the generators are isolated from the van chassis by mounting the generators on rubber blocks in two separate locations.

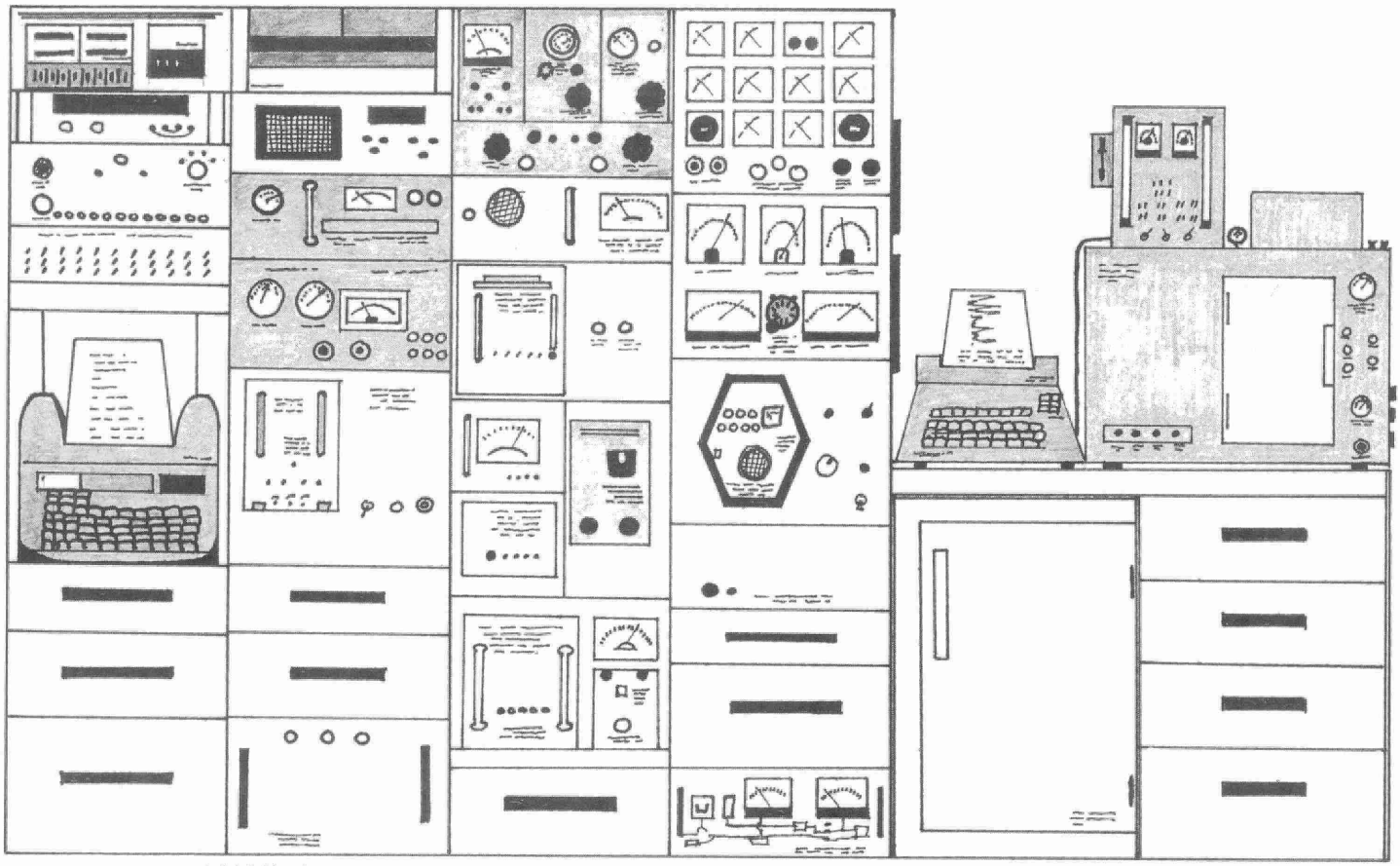
Two independent electrical circuits exist within the van and either or both circuits may be engaged into either generator.

One circuit provides power to all monitoring instrumentation and the data acquisition system. A constant voltage regulator is series tapped within the circuit to provide 117 VAC to the instrumentation. Valuable information encoded within calculator memory may be lost during a power interruption, therefore a secondary uninterruptable power supply also exists within the circuit for emergency shutdown procedures. This supplies power from a large battery bank and provides it instantaneously whenever line voltage drops below a critical level. When a power interruption occurs, power is provided to the data acquisition system to update and terminate operations automatically. In this manner, no data in calculator memory is lost as it is transferred to the magnetic tape cartridge through this emergency shutdown measure.

The second circuit is not regulated and supplies power to the appliances such as the electric heaters, air-conditioners, lights, receptacles and pumps. Usually one generator provides power to one circuit; however, in times of mechanical failure of one generator, the second generator may be engaged to provide power to both circuits.

The electrical operating status of the MAM Unit is displayed for immediate inspection. Such parameters as voltage, current, frequency and accumulated operating hours from each generator are presented. In addition, voltages and current from the constant voltage regulator and supplementary 12-V.D.C. battery systems are also displayed.

For semi-permanent locations, a 50 ampere, 200 VAC, receptacle is installed for connection to exterior electrical power.



MAM's Instrumentation

Instrumentation

The data acquisition system is considered to be the heart of the Unit. The system consists of a Hewlett-Packard 9830A desktop computer with an eight-thousand word memory, a digital voltmeter (D.V.M.), an analogue/digital converter, a quartz crystal clock used as a time base, a scanner which on command selects the proper signal channel to be interrogated and a dual-tape cartridge read/write unit. Also included is an instrument controller which opens/closes the communication channels between computer and instrumentation. The instrument controller provides a manual override function during data acquisition system failure.

The data acquisition system have been designed to receive information from analytical instrumentation and store it on magnetic tape for later evaluation. The operator has the choice of scanning/recording a single pollutant or combination of pollutants, calibrating the instruments or doing simple data reduction and verification.

Located on a bench at the rear of the vehicle is a six pen chart recorder used as a backup instrument when the data acquisition system fails. Primarily it is used as a visual aid when determining an ambient air profile. Through utilization of a select-a-board mounted below the scanner, any instrument may be connected to the recorder and/or to the digital voltmeter.

All aspects of the system had been completely interfaced with the computer and all operations are controlled by the computer. Automated, independent and continuous monitoring capabilities are the major features of this system.

The majority of the ambient air monitoring instrumentation and data acquisition system are mounted in 4 instrument racks which have been shock mounted to minimize transmission of vibration.

The mercury vapour (Hg) analyzer is an ultraviolet spectrometer with a 10 meter light path. It detects mercury vapour in ambient air by measuring the attenuation of the mercury emission line at 253.7 nm. The sensitivity to other compounds, which may absorb at the same wavelength, is highly suppressed by the utilization of the Zeeman effect.

The hydrocarbon (CxHy) analyzer is a dual flame ionization detector that measures total hydrocarbons, non-methane and methane in ambient air. The sample air stream is divided into two; one-half goes directly to one flame ionization detector and one-half goes to the second flame ionization detector via a catalyst which selectively burns down all hydrocarbons higher than methane. In this manner, one detector measures total hydrocarbons and the other measures only methane. The difference between the two electronic signals is electronically subtracted and displayed as non-methane hydrocarbons. The instrument operates with a sensitivity of 20 ppm of hydrocarbons (expressed as methane) full scale.

The non-dispersive infra-red carbon monoxide (CO) analyzer makes use of the specific radiation absorption by carbon monoxide gas in the infrared region between 4.5 um and 4.9 um. To eliminate the interference caused by moisture, it utilizes a flow-through reference cell. The carbon monoxide analyzer works with a sensitivity of 100 ppm full scale. The hydrocarbon and carbon monoxide analyzers are the only instruments where cylinders of compressed gas standards are used for calibration.

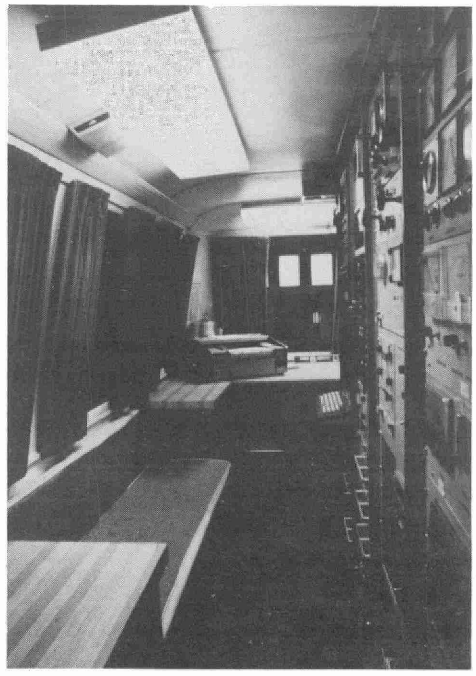
The hydrogen sulphide (H_2S) analyzer uses an electrolytic Nernst type cell. The measured gas (hydrogen sulphide) causes a change in the concentration of Ag^+ ions on the test electrode and consequently a measureable current. Thus the cell takes on the function of a Nernst's concentration chain. The maximum sensitivity with which the analyzer measures is 50 ppb hydrogen sulphide full scale, however the sensitivity can be continuously decreased to measure up to 2 ppm of hydrogen sulphide. A hydrogen sulphide gas generator, containing a permeation cell, is used as a calibration source.

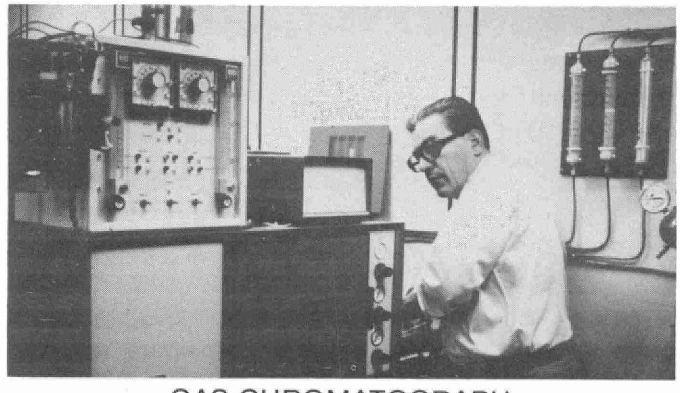
The sulphur dioxide (SO_2) analyzer measures the changes in conductivity of a dilute solution of phosphoric acid and hydrogen peroxide in water caused by the presence of sulphur dioxide in ambient air. The sensitivity to other compounds which may also change the conductivity of the solution (as NH_3, HC1, PH_3, etc.) is highly suppressed by a special selective filter. The instrument has two measuring ranges. The more sensitive range measures to 0.3 ppm full scale. If the concentration of sulphur dioxide in ambient air exceeds the maximum value for this range the analyzer automatically switches over to the next range which measures from 0 to 3 ppm full scale. Similar to the hydrogen sulphide source, a gas generator containing a sulphur dioxide permeation cell is used as a calibration source.

The ozone analyzer measures gaseous ozone by ultraviolet absorption. This analyzer has several inherent self-compensation features which automatically self-calibrate and hence provide minimum operator attendance. This instrument has two sensitivity ranges; 0 to 0.5 ppm and 0 to 1.0 ppm and also an internal calibrated ozone source.

The oxides of nitrogen (NOx) analyzer utilizes the principle of photometric detection of the chemiluminescence resulting from the gas phase reaction of nitric oxide (NO) and ozone (O_3). Two cycles of operation are required to determine the amounts of NO, nitrogen dioxide (NO_2) and their sum (NO_X). One cycle passes the ambient air sample directly to the reaction chamber and determines

Interior of MAM Unit





GAS CHROMATOGRAPH

the amount of NO in the sample. The other cycle passes the ambient air sample through a device which passes NO and converts NO_2 to NO. The total NO then flows to the reaction chamber to determine the amount of NO_X. The NO_2 measurement is derived from the NOx and NO difference.

A permeation cell source and converter supplies a calibrated gas mixture of NO and NO_2 which is used for calibration of this instrument.

The reporting gas chromatograph is the most versatile and practical instrument carried on the MAM Unit. It is mounted on a bench directly behind the drivers seat and its operation is regulated by an independent micro-processing unit.

This instrument has the ability to qualify and quantify ambient air samples for hundreds of unique pollutants in low concentrations due to the test components' individual and distinctive chemical properties. Its application to mobile air monitoring is usually preceded by extensive and intensive development work because of the demanding nature of air monitoring. Operating parameters and procedures are investigated and defined for each unique pollutant.

Located on the roof are sensors for monitoring relative humidity, solar radiation, temperature and barometric pressure. A retractable telescopic 10 metre mast, which is operated from within the Unit, carries on the mast-head, sensors that monitor the wind speed and wind direction. All meteorological data is displayed on meters within the Unit and interfaced with the data acquisition system.

For measurement of wind and temperature aloft, a single theodolite/minisonde receiver unit interfaced with the data acquisition system has been installed in the unit.

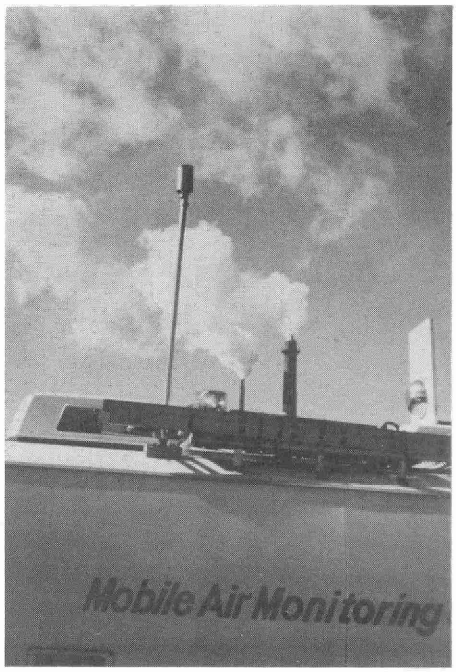
Should it be required, additional analyzers can be mounted into the unit on a temporary or permanent basis. The data acquisition system has provisions for adapting three of these instruments.

Due to the high consumption of highly purified air (zero air) by the gas chromatograph and other instruments, a zero air source was installed. This source produces absolutely clean air from pressurized ambient air by chromatographic techniques. As the unclean air enters the system, it passes through several selective absorption columns which keeps the air mass flow rate constant. Computer controlled, solenoid operated gas circuits are utilized to direct this zero air and other process gases to the various instruments.

During field surveys the recommended service schedule is followed to ensure proper operation of all instruments and hardware. The instrument response is checked daily through calibration and use of built-in electronic circuitry. Instrument hardware that commonly needs replacement is carried onboard to ensure a minimum of down-time. A duplicate set of operating instrumentation can be delivered to the MAM Unit when the original instrument cannot be repaired on site.

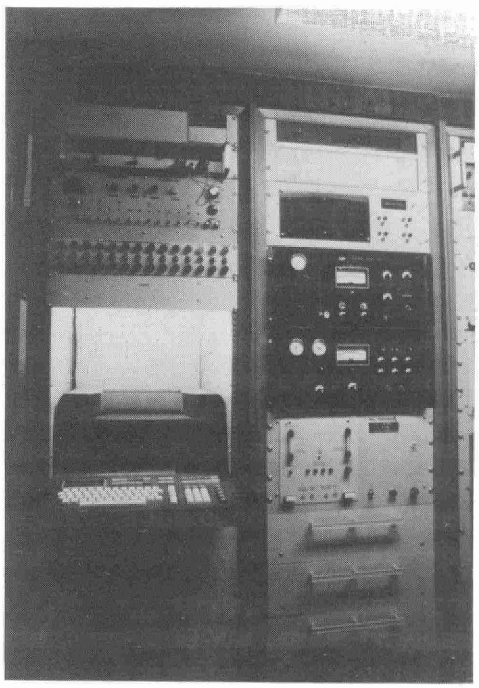
All instruments and internal gas sources are calibrated in the laboratory prior to field work. Much of this work is done during the winter months when the unit is taken to home base for major refit. All instrumentation/filters are reconditioned/replaced and instrument response is investigated and compared to manufacturer's specifications. At this time, system improvements and modifications that have been suggested during the field work months are developed and implemented.

OIL REFINERY COMPLEX



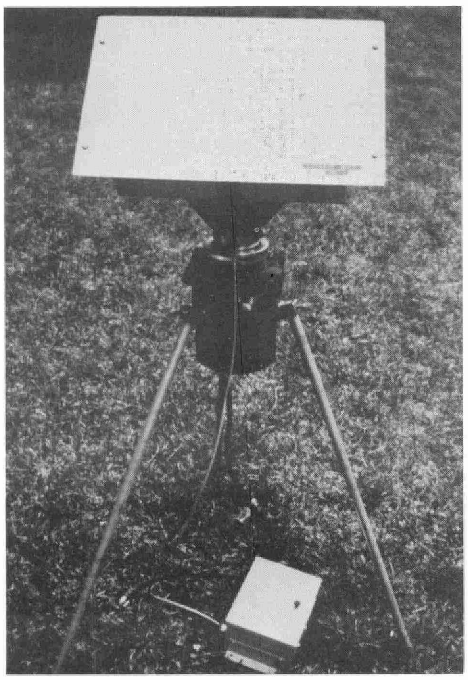
SAMPLING ORIFICE

DATA ACQUISITION SYSTEM

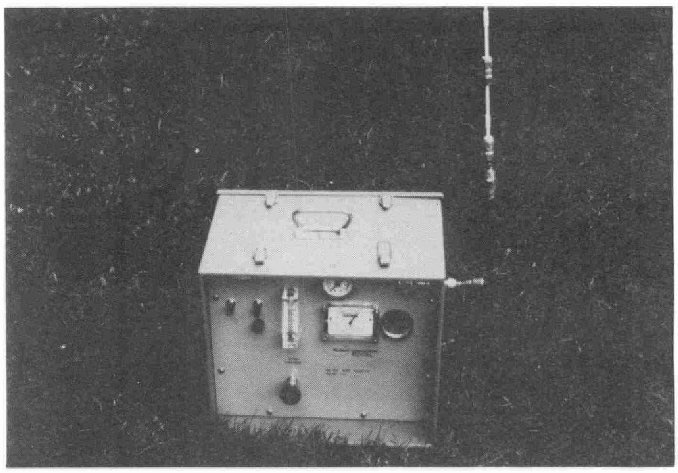


Miscellaneous Features

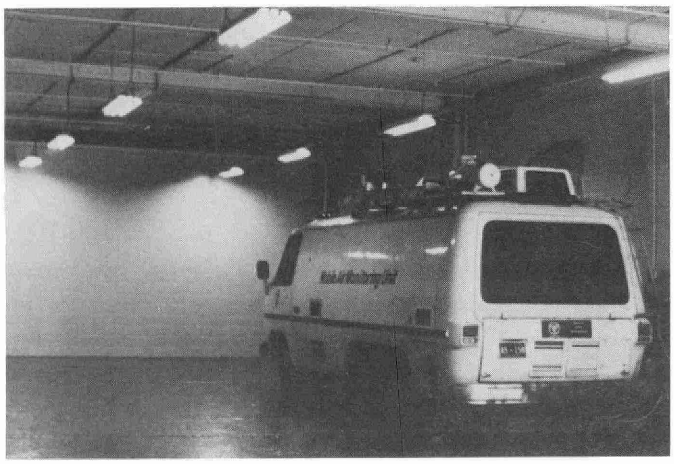
1) Status lights to indicate the position of the meteorological tower, sample probe and roof hatch.
2) Two roof mounted amber emergency lights.
3) A 50 watt, FM-mobile transmitter/receiver for communication with support vehicles.
4) Mobile radio-telephone for communication over extended distances.
5) Electrical and conventional fire extinguishers.
6) First Aid Kit.
7) Gas tank capacity of 72 Imperial Gallons.
8) Aluminum catwalk and ladder to provide access and footing on roof of vehicle.



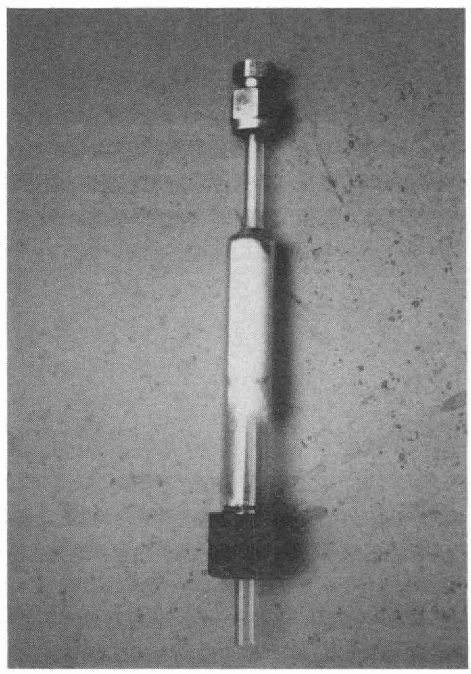
HIGH VOLUME SAMPLER



NUTECH SAMPLER



MAM Unit at Home Base



TENAX CARTRIDGE

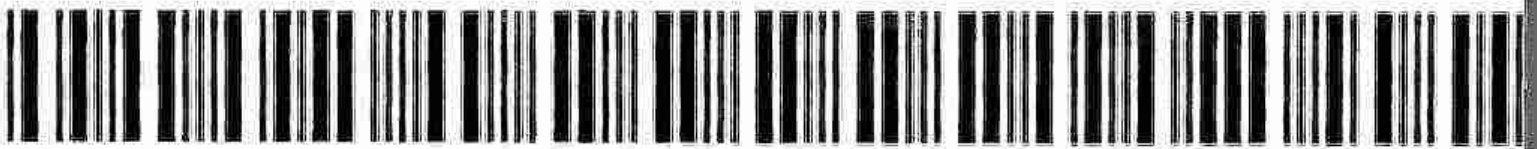
MISSISSAUGA TRAIN DERAILMENT SITE

The MAM Unit was originally designed to support Ontario's air quality management program. Its present and future activities include monitoring the success of these abatement/management programs. The investigation of air pollution episodes and other special ambient air survey requests constitute the major work load of this Unit. In cases where dangerous chemical spills, fires or disposal sites present hazardous conditions to the public, it is often used to sound an alarm if toxic compounds appear in the environment.

The list of potential uses will certainly grow as the Unit is used and refined.

MAM and TAGA Units

MAM Unit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